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## **Psychoco: Psychometric computing in R**

Wickelmaier, Florian ; Strobl, Carolin ; Zeileis, Achim

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## Psychoco: Psychometric Computing in R

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### Abstract

This special volume features eleven contributions to psychometric computing, a research area that integrates psychometrics and computational methods in statistics. Topics covered include structural equation modeling, item response theory, probabilistic choice modeling, and other modeling approaches prevalent in or useful for psychometric research. Each contributed paper is accompanied by a software package published on the Comprehensive R Archive Network. This introduction gives a brief overview of the volume.

*Keywords:* psychometric computing, structural equation models, item response theory, Rasch model, choice models, paired comparisons, preferences, computerized adaptive testing, R.

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## 1. Introduction

Psychoco is an acronym that stands for psychometric computing and that was coined for a series of workshops (see <http://www.psychoco.org/>). Starting out in 2009 as a meeting of only a handful of psychophile statisticians and methodology-minded psychologists, it has in the meantime grown into an annual international workshop that attracts more than forty attendants. Trend: upwards.

The aim of the workshops is to bring together researchers from statistics, psychology, and related disciplines working on modern techniques for the analysis of data from psychology and the social sciences. It provides a platform for discussions about implementation and application of software on the interface of statistical inference, computational methods, and applied psychometrics – with special emphasis given to the R system for statistical computing (R Development Core Team 2012). The meetings attract both authors and users of psychometric software, creating a diverse program and inspiring atmosphere. This special volume in the *Journal of Statistical Software* (JSS) is a first progress report from the Psychoco workshops. Five years ago, in their introduction to the JSS special volume “Psychometrics in R,” De Leeuw and Mair (2007) deplored that psychometrics and statistics developed into disjunct

scientific communities, the members of which hardly took note of each other. Their special volume had been compiled with the hope of bringing these two communities closer together. In the series of Psychoco workshops and in this new special volume focusing on computational methods for psychometrics, we see evidence that this is indeed beginning to happen – with the R system being particularly instrumental to the process as a common “lingua franca” for the exchange of ideas and methods.

The series of Psychoco workshops has evolved into a platform where psychometric research meets state-of-the-art statistical computing. In this scientific community, skillful open-source implementations of the most prevalent psychometric methods have been developed, some of which are presented in this volume. Moreover, the stimulating environment of this interdisciplinary research area has also fostered the development of new estimation approaches for specialized models as well as entirely new psychometric methodology: In the past years, presentations given at the Psychoco workshop series have included the use of generalized linear mixed models (GLMMs) for estimating classical models of item response theory (De Boeck *et al.* 2011), recursive partitioning to account for parameter heterogeneity in psychometric models (Strobl, Wickelmaier, and Zeileis 2011; Zeileis, Strobl, Wickelmaier, and Kopf 2011), and flexible estimation procedures for structural equation models (Monecke and Leisch 2012; Rosseel 2012), to name only few examples.

Today’s special volume features a collection of new or substantially enhanced psychometric software packages that have been presented at the Psychoco workshops. All of them are on the Comprehensive R Archive Network (CRAN, <http://CRAN.R-project.org/>) and listed in the “Psychometrics” task view (Mair 2012).

## 2. Contributions to the special volume

This volume includes contributions to structural equation models (SEMs), item response theory (IRT), probabilistic choice modeling, and other modeling approaches prevalent in or useful for psychometric research.

The first paper by Rosseel (2012) introduces **lavaan**, a feature-rich package for structural equation modeling. In the best spirit of free and open-source software, it aims at rendering unnecessary commercial or closed-source SEM software in the field. This is achieved not least by the `mimic = "MPlus"` and `mimic = "EQS"` options contained in **lavaan**’s fitting functions. A partial least squares approach to SEM – an alternative to covariance-based SEM that is especially suitable for non-normal data – is available in **semPLS** (Monecke and Leisch 2012). Concluding this section of this volume, **qgraph** (Epskamp, Cramer, Waldorp, Schmittmann, and Borsboom 2012) provides data visualization tools especially tailored to the needs of psychometricians. It includes easily accessible interface functions to high-level plotting procedures that will turn uninspiring correlation matrices and tables of factor loadings into fancy graphs.

The IRT part of the volume starts out with new developments in Mokken scale analysis (Van der Ark 2012) that have been incorporated in the **mokken** package (see Van der Ark 2007). A new class of IRT models with tree-structured decision rules is covered by De Boeck and Partchev (2012). As in the precursor papers (Doran, Bates, Bliese, and Dowling 2007; De Boeck *et al.* 2011), the authors draw on functionality provided by the `glmer()` function in the **lme4** package (Bates, Mächler, and Bolker 2011) and recast their new models as GLMMs. Utility functions and data sets are included in their **irtrees** package. Chalmers (2012) intro-

duces multidimensional IRT models implemented in the **mirt** package. So far, this package is the only one on CRAN that allows one to perform multidimensional confirmatory factor analysis. Different flavors of Rasch mixture models are featured in the **psychomix** package (Frick, Strobl, Leisch, and Zeileis 2012). These models can be used to detect latent classes with different parameter values, including differential item functioning (DIF). The final contribution to this part of the volume is by Magis and Raïche (2012) on response pattern generation under computerized adaptive testing. Their **catR** package includes several methods for item selection, methods for ability estimation, and stopping rules.

Two contributions document ongoing research activities in modeling probabilistic choices: The **BradleyTerry** package (Firth 2005) has evolved to the next generation **BradleyTerry2** (Turner and Firth 2012). It now includes Bradley-Terry models with contest and (random) player effects as well as various estimation methods. The **prefmod** package (Hatzinger and Dittrich 2012) has been continuously extended over the years. It now contains a wealth of choice models, among them the log-linear Bradley-Terry model, the paired comparison pattern model, and models for rating and ranking data.

The final paper (Grün, Kosmidis, and Zeileis 2012) presents extended methods for beta regression, a technique for modeling rates and proportions. The **betareg** package, previously introduced by Cribari-Neto and Zeileis (2010), is complemented by options for bias-corrected and bias-adjusted estimation of beta regressions as well as functions for model-based recursive partitioning and for fitting finite mixture models. Thus, it provides yet another example where psychometric application and modern statistical computing are closely integrated.

### 3. Concluding remarks

This special volume constitutes a snapshot of a scientific field that is in constant motion. Psychometric computing offers statisticians, psychologists, and researchers in related disciplines the opportunity to jointly develop new methods and software. Being an open-source system, R is an ideal language to exchange ideas. If you would like to contribute to this exciting interdisciplinary research area, you are cordially invited to join us at one of the next Psychoco workshops. See the workshop web page (<http://www.psychoco.org/>) for dates and details.

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